

To: EAAC

**From: Cathy Kunkle and Daniel M. Kammen
Energy and Resources Group
University of California
Berkeley, CA 94720-3050**

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Summary: We analyze the extent to which a cap and dividend policy (in which carbon allowances are auctioned and a fraction of the revenue is returned to citizens in the form of equal per capita dividends) can compensate households for the increased costs of electricity, natural gas, and gasoline resulting from a carbon price. In general, the cap and dividend policy is progressive, with a larger fraction of households in the lower income deciles receiving positive net benefits. When more than 75% of income is returned to the public, the majority of households receive positive net benefits across all income deciles. The detailed results are most sensitive to the assumed elasticity of demand for gasoline, which in some of our scenarios is allowed to vary across income deciles.

Introduction

We assess the impact of a cap and dividend policy in CA across different regions of the state for different levels of income. We model the cap and dividend policy by assuming that 100% of permits are auctioned and a given fraction of the auction revenue is returned to the public in the form of equal per capita dividends. We also model the impact on consumers of increased costs of electricity, natural gas, and transportation fuels, neglecting the increased cost of general consumer goods. We expect these costs to vary geographically because of the large variation in carbon intensity of electricity by region, as well as the variation in natural gas use and gasoline use (both electricity carbon intensity and gasoline consumption vary by nearly a factor of four across the state, as shown in Figures 1 and 2).

Methodology

The American Community Survey provides data on household incomes and electricity expenditures for nearly 400,000 households in CA, which we aggregate into 41 regions (individual counties or groups of counties) and sort into deciles of per capita income. Matching each region with the electric utility(s) serving the region, we can calculate the increase in expenditure due to higher electricity prices in 2020¹. The electricity sector is assumed to de-carbonize by 10% relative to 2007, in line with CA's goal of reducing emissions to 1990 levels by 2020. We assume that this requires a carbon price of \$20/tC.

¹ A few of the regions are missing data for important local utilities. Specifically, the region comprising Del Norte, Lassen, Modoc, and Siskiyou Counties is missing Lassen MUD, Pluma/Sierra Co-op, and Surprise Valley Electric Corporation. The region of Colusa, Glenn, Tehama, and Trinity Counties is missing Trinity County Public Utility District. And the region of Nevada, Plumas, and Sierra Counties is missing Lassen MUD and Plumas/Sierra Co-op.

Electricity prices in 2020 are determined by an assumed annual real rate of price escalation (independent of the carbon price) and by the carbon price.

Our 41 regions are then matched with the natural gas utility(s) serving each region in order to calculate the increase in expenditure due to higher natural gas prices in 2020.² Natural gas prices in 2020 are determined by an assumed annual real rate of price escalation (independent of the carbon price) and by the carbon price. Natural gas consumption in 2020 is calculated by assuming a price elasticity of demand of -0.2.³

Household transportation expenditures are estimated using Bureau of Labor Statistics Consumer Expenditure Survey data to calculate per capita gasoline consumption by decile in California, and the results are given in Figure 3. These expenditures are then weighted by region based on California Energy Commission data on total gasoline consumption by region in 2006.

Our results are highly sensitive to the demand elasticity of gasoline. It has been noted that demand for gasoline is more elastic for lower deciles, despite the fact that households in these deciles use less gasoline to begin with. Thus, in some scenarios, gasoline consumption is determined by using demand elasticities that vary by quintile from West and Williams, 2002⁴; elasticities are given in Table 1. (Note: West and Williams divides households into quintiles by household income, not per capita income, but we ignore this difference for the moment). The average elasticity in Table 1 is approximately -0.65, which is a plausible estimate for the long-term elasticity of gasoline. Other scenarios use a demand elasticity of -0.3, constant across deciles; this lower elasticity is a reasonable estimate of short-term demand elasticity for gasoline. The gasoline price in 2020 is determined by an assumed annual real rate of price escalation (independent of the carbon price) and by the carbon price.

We consider two price escalation scenarios:

1. The rates of electricity, natural gas, and gasoline price increases are all 0%. The rationale for considering this scenario is that the cap and dividend policy is only meant to protect consumers against price increases due to the policy, not from the general upward trend in real gasoline prices.
2. The rates of electricity, natural gas, and gasoline price increases follow historical trends. As shown in Figures 4 and 5, nominal electricity prices have increased 2.3%/year in CA and nominal gasoline prices have increased 5.6%/year over the

² Natural gas prices for 2007 were obtained from EIA Form 175 for the following utilities: City of Long Beach, Pacific Gas and Electric, San Diego Gas and Electric, Southern California Gas, and Southwest Gas. For the remaining utilities, an average price of \$11.57/Mcf was used.

³ J.K. Boyce and M. Riddle, "Cap and Dividend: How to Curb Global Warming While Protecting the Incomes of American Families," Political Economy Research Institute, November 2007.

⁴ S.E. West and R.C. Williams, "Estimates from a Consumer Demand System: Implications for the Incidence of Environmental Taxes" *Journal of Environmental Economics and Management* 47.3 (2004): 535-558.

past couple of decades; natural gas prices have increased 6.4%.⁵ Subtracting out inflation of 2-3%/year, we assume real rates of increase of 0%/year for electricity, 3%/year for gasoline, and 4%/year for natural gas. Under this scenario, the gasoline price increases from \$3.6/gallon to \$5.3/gallon in 2020.

Results

A. 0% price escalation scenario

Figures 6 and 7 show the fraction of households in the top and bottom deciles receiving positive net benefits at a carbon price of \$20/tC (i.e. the per capita dividend more than offsets fuel price increases for these households). These figures were generated assuming that demand elasticity for gasoline varies across deciles. For clarity, and to emphasize the geographic variation, Figures 6 and 7 each include only the 5 regions with the fewest households receiving positive net benefits and the 5 regions with the most households receiving positive net benefits. In general, the bottom decile fares better under the policy, although some regions, notably Imperial County, Shasta County, and Del Norte/Lassen/Modoc/Siskiyou Counties, show significantly fewer households receiving dividends. Imperial County (which is served by Imperial Irrigation District) has the highest household electricity consumption of all the regions, which accounts for the higher impact of increased electricity prices. Del Norte/Lassen/Modoc/Siskiyou also has high household electricity consumption, driven by the cheap price of electricity from PacifiCorp, the dominant utility; PacifiCorp also has the highest carbon intensity of any of the utilities considered. (However, results for Del Norte/Lassen/Modoc/Siskiyou may be misleading because we are missing carbon intensity data for 2 utilities serving the region: Lassen MUD and Plumas/Sierra Co-op.) Sacramento County, served by SMUD, consistently fares near the top, due to SMUD's very low carbon intensity.

The use of variable demand elasticities for gasoline, as opposed to elasticities that are constant across the deciles, further increases the progressivity of the distribution of net benefits. For the poorest decile, all but 1 region have more than 80% of households receiving positive net benefits even with the government appropriating 50% of the total revenue. For the wealthiest decile, only San Francisco County has more than 80% of households receiving positive net benefits at this level of dividend.

Figures 8 and 9 show the same scenario but now assuming a constant short-term elasticity of -0.3 across the deciles. The results are qualitatively similar to Figures 6 and 7, but overall fewer households receive net benefits because households are spending more on transportation expenditures.

B. Historical price escalation scenario

Using the gasoline price elasticities given in Table 1, the fraction of households in the poorest decile receiving a positive net benefit from the policy is shown in Figure 10. Again, this figure is qualitatively similar to Figure 6, but with fewer households receiving positive net benefits overall. For the poorest decile, only 18 regions have more than half

⁵ Energy Information Administration, "California Price of Natural Gas Delivered to Residential Consumers (Dollars per Thousand Cubic Feet)", <http://tonto.eia.doe.gov/dnav/pet/hist/n3010ca3a.htm>, June 29, 2009.

of households receiving positive net benefits with the government appropriating 50% of the total revenue. For the wealthiest decile, no households receive positive net benefits across all regions.

Because the transportation price increases so much by 2020 in this scenario (nearly 50%), the results are highly sensitive to the assumed demand elasticities for gasoline; at lower elasticities (e.g. -0.3), the increased transportation and natural gas expenditures can entirely wipe out the positive net benefits across all regions. Combined with our results from section (A) above, this suggests that the cap and dividend policy will be able to more than offset the increase in fuel prices due to the carbon price for most households but will not necessarily offset fuel price increases in general.

Tables

1st	2 nd	3rd	4th	5th
-0.67	-0.79	-0.69	-0.78	-0.34

Table 1. Price elasticity of demand for gasoline by quintile. Source: West and Williams, 2002.

Figures

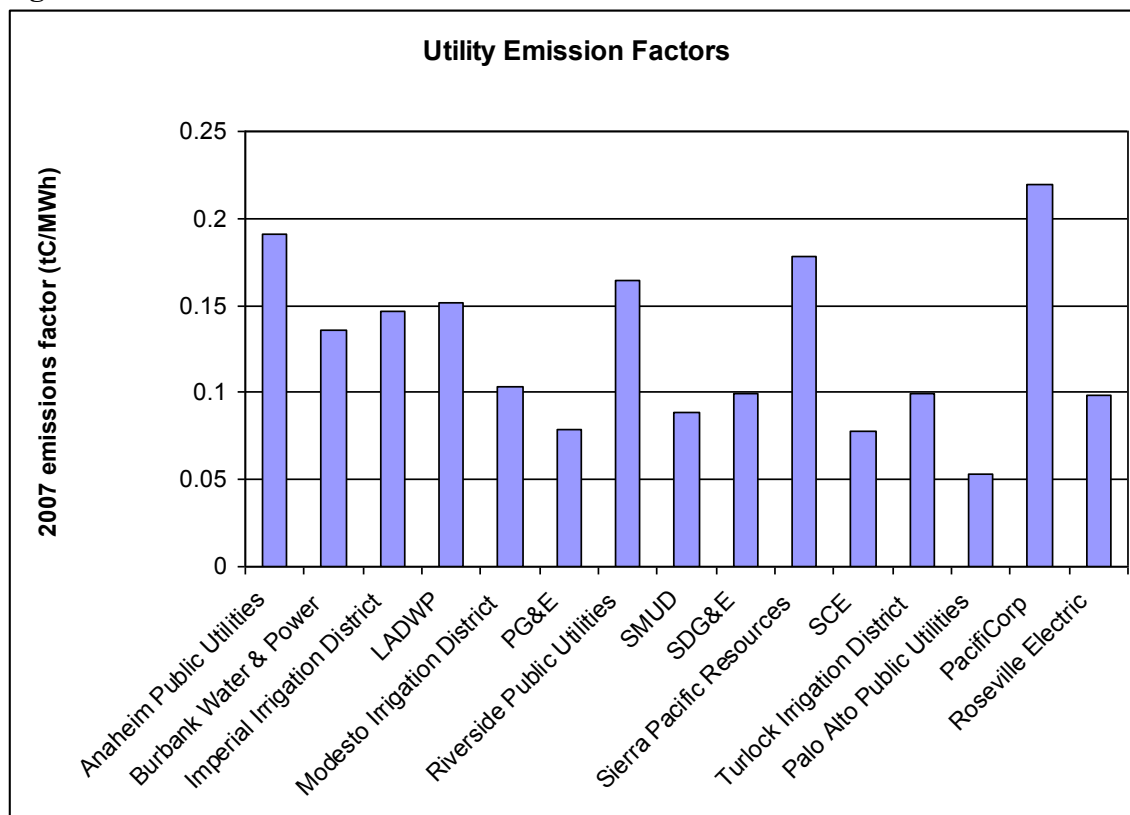


Figure 1. 2007 emissions factors for major CA utilities. Source: California Climate Action Registry.

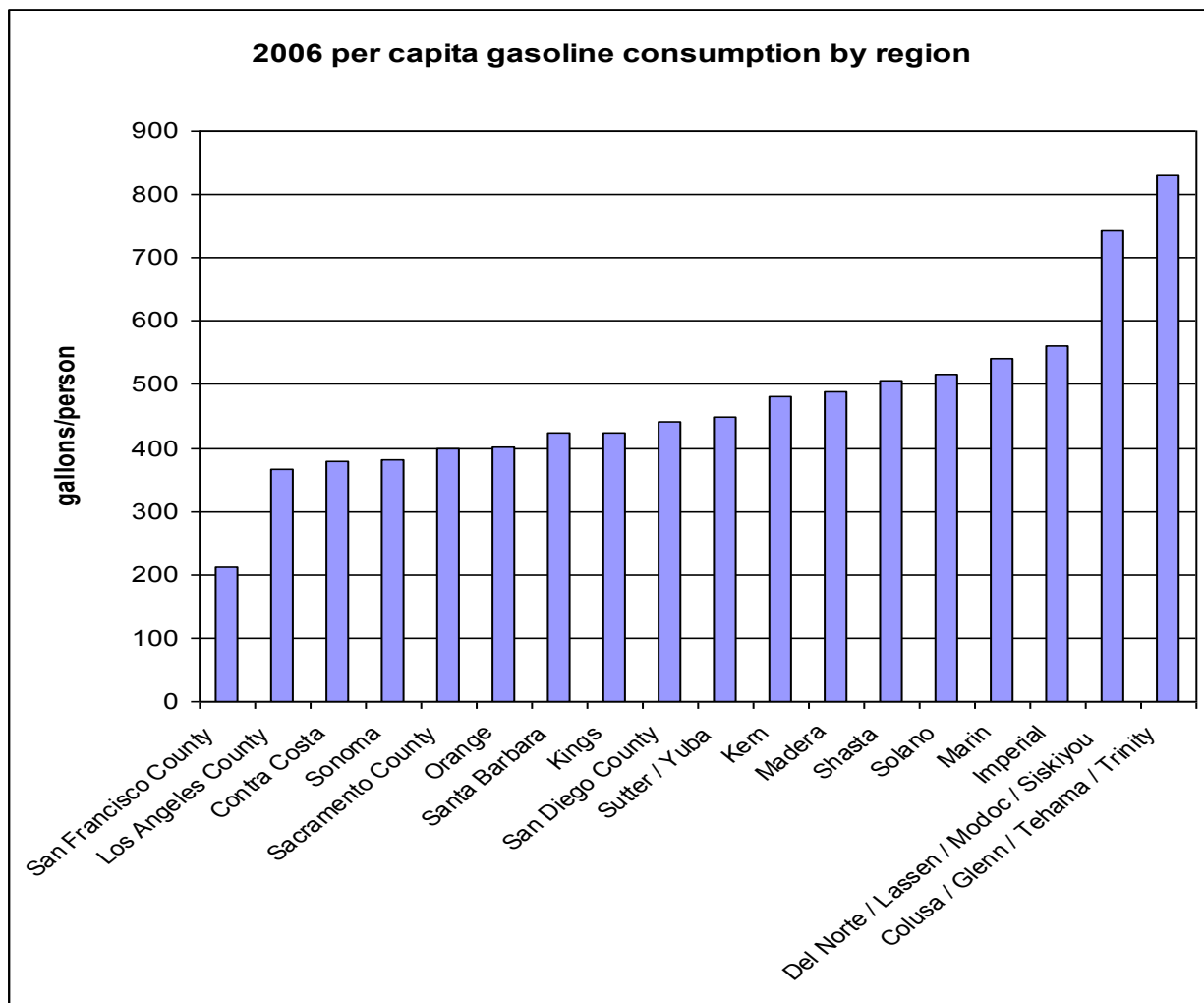


Figure 2. Per capita gasoline consumption for selected regions. Source: California Energy Almanac (CEC), and U.S. Census Bureau

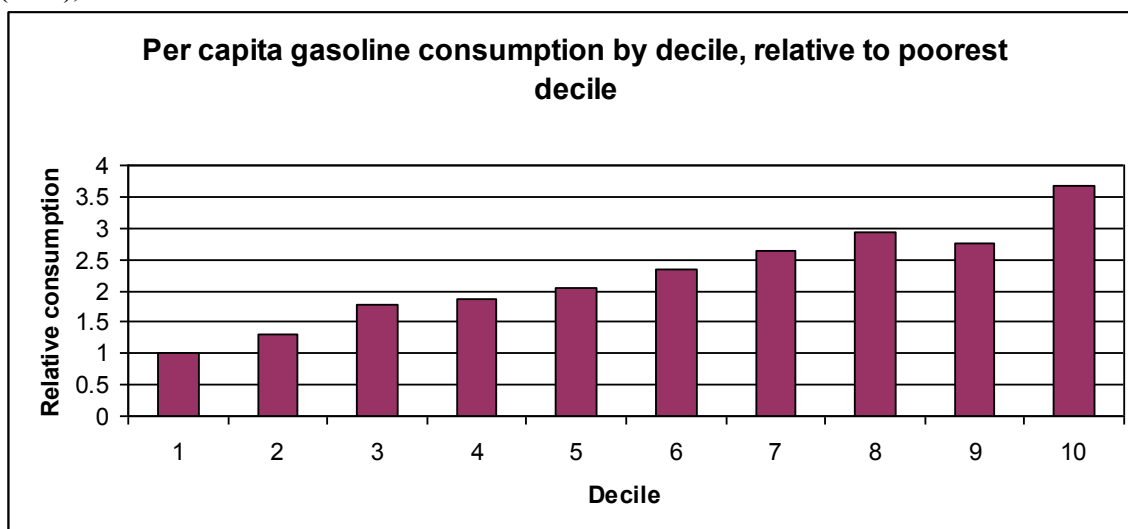


Figure 3. Per capita gasoline consumption by per capita income decile in CA. Source: Bureau of Labor Statistics Consumer Expenditure Survey

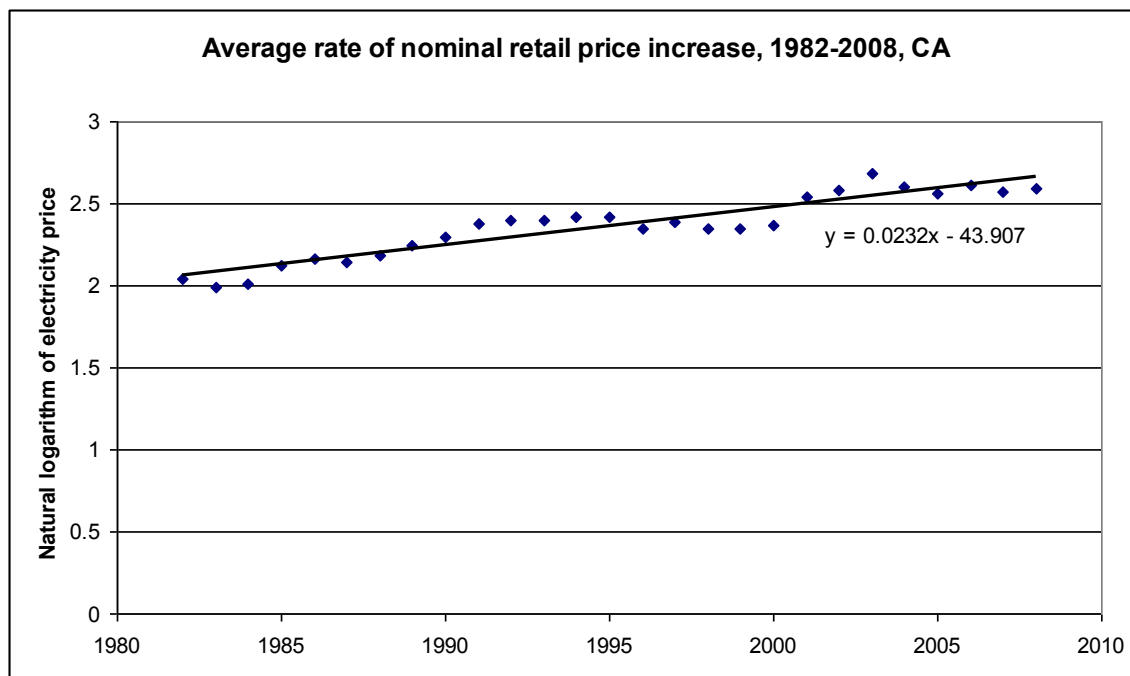


Figure 4. Nominal electricity prices in CA increased at 2.3%/year from 1982-2008. Source: California Energy Commission, Energy Almanac.

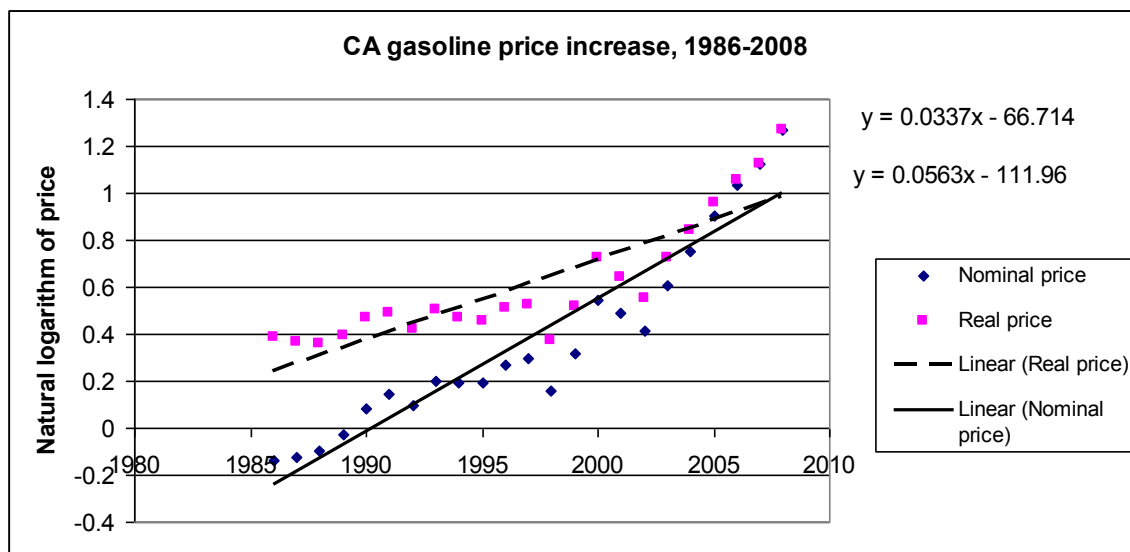


Figure 5. Gasoline prices in CA increased at 5.6%/year (nominal) and 3.4%/year (real) from 1986-2008. Source: California Energy Commission, Energy Almanac.

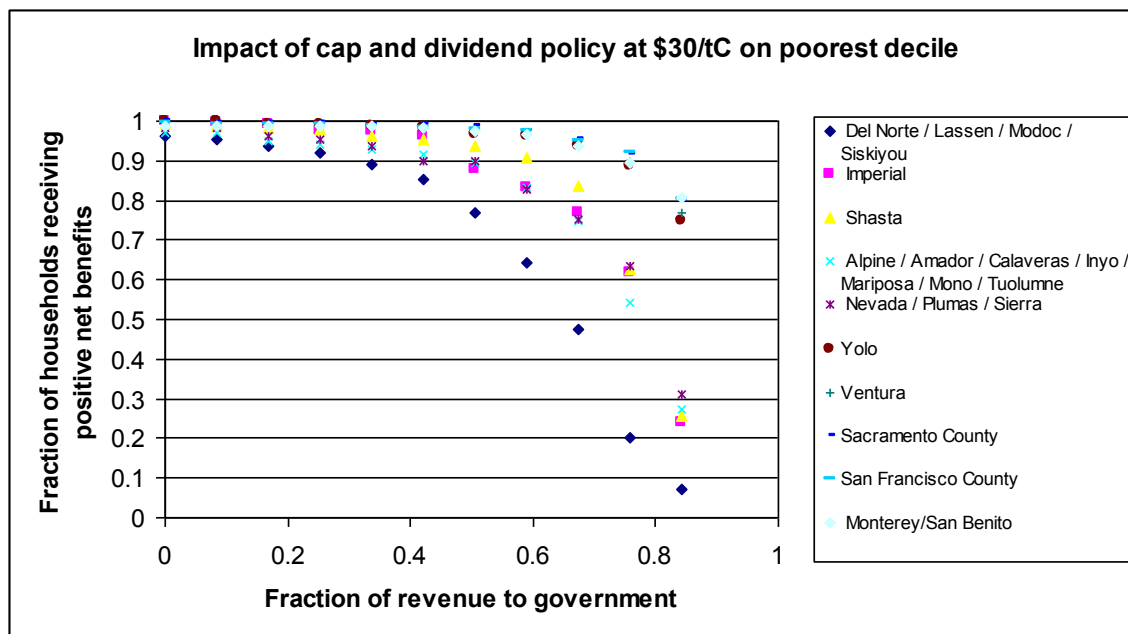


Figure 6. Fraction of households in poorest decile receiving net dividend for selected regions as a function of revenue returned to government. Carbon price: \$30/tC, 0% price escalation. Elasticities of demand for gasoline vary across deciles, as given in Table 1.

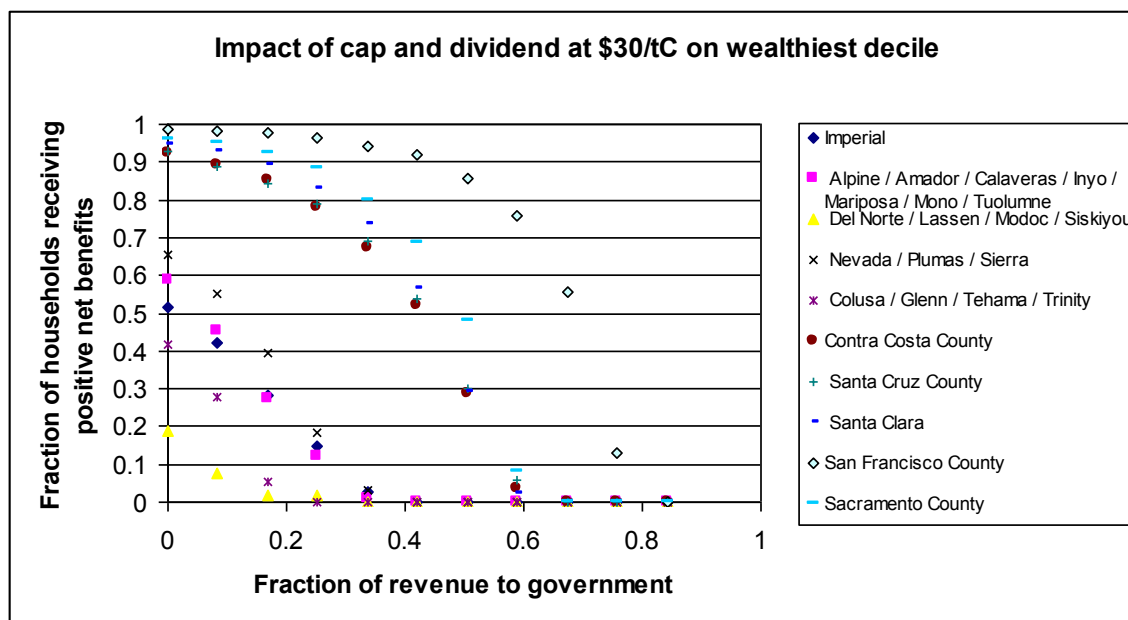


Figure 7 Fraction of households in wealthiest decile receiving net dividend for selected regions as a function of revenue returned to government. Carbon price: \$30/tC, 0% price escalation. Elasticities of demand for gasoline vary across deciles, as given in Table 1.

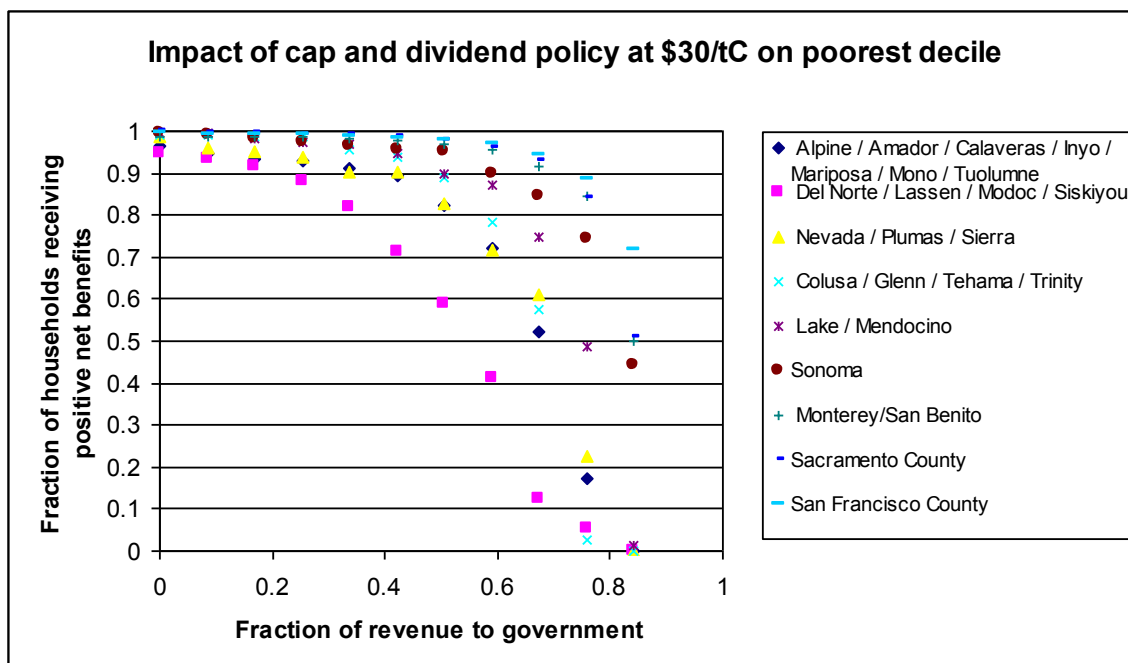


Figure 8. Fraction of households in poorest decile receiving net dividend for selected regions as a function of revenue returned to government. Carbon price: \$30/tC, 0% price escalation. Elasticity of demand for gasoline = -0.3

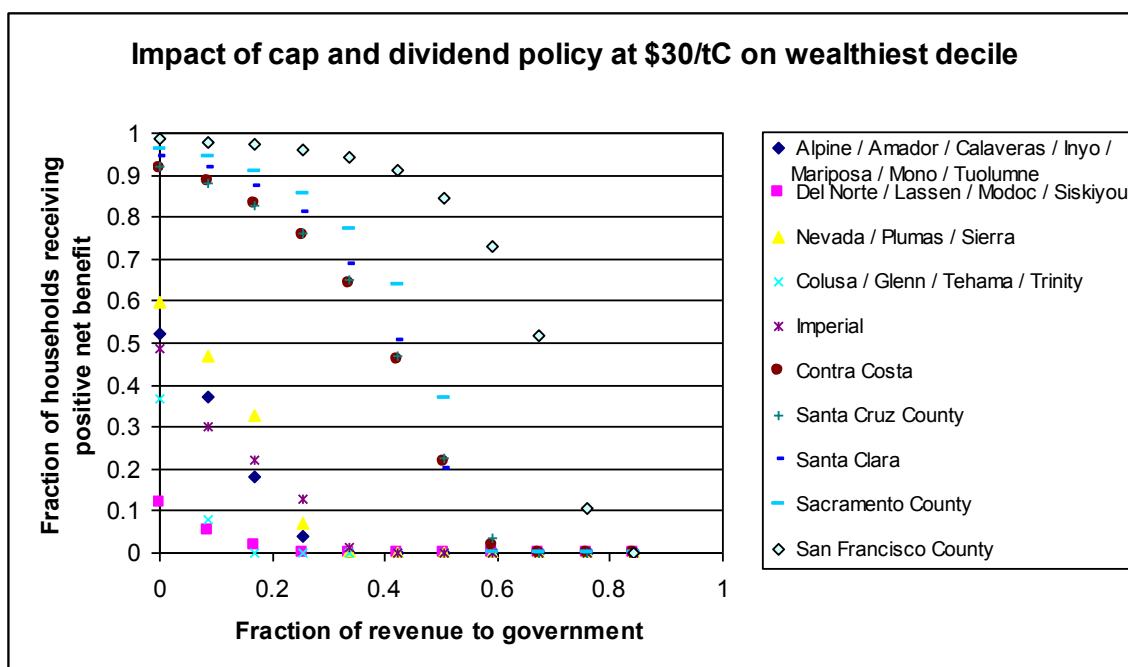


Figure 9. Fraction of households in wealthiest decile receiving net dividend for selected regions as a function of revenue returned to government. Carbon price: \$30/tC, 0% price escalation. Elasticity of demand for gasoline = -0.3

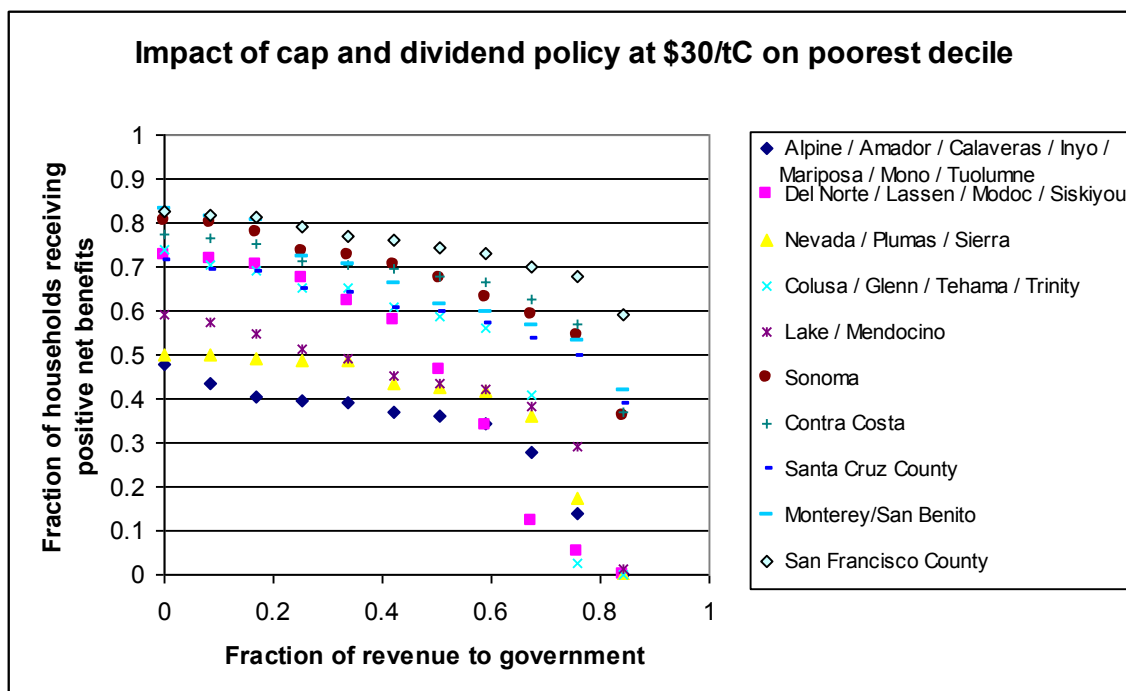


Figure 10. Fraction of households in poorest decile receiving net dividend for selected regions as a function of revenue returned to government. Carbon price: \$30/tC, historical price escalation (0%/year for electricity, 3%/year for gasoline, 4%/year for natural gas). Elasticities of demand for gasoline vary across deciles, as given in Table 1.